University of Oklahoma Research Institute

TOWARD A PSYCHOLOGICAL INDEX OF
WEAPONS EFFECTIVENESS
PART I: FIELD STUDIES

By

R. A. Terry

Contract AF 08(635)-3693
Report 1419-5

December, 1964

Technical Report

TOWARD A PSYCHOLOGICAL INDEX OF WEAPONS EFFECTIVENESS

PART I: FIELD STUDIES

By

R. A. Terry

Report 1419-5

Contract AF 08(635)-3693

UNIVERSITY OF OKLAHOMA
RESEARCH INSTITUTE
Norman, Oklahoma

December, 1964

TABLE OF CONTENTS

TOWARD A PSYCHOLOGICAL INDEX OF WEAPONS EFFECTIVENESS

PART I: FIELD STUDIES

R A. Terry

The Concept of the Psychological Index: To compare non-nuclear weapons with respect to their psychological effectiveness requires a scaling procedure which will allow numbers to be assigned to these weapons or to their characteristics according to some rule. A broad working definition of the psychological index, therefore, will be: A scaling procedure permitting quantitative description of the psychological effectiveness of weapons.

Historical Background

Detailed examination of the literature reveals that the psychophysical methods commonly employed in the development of psychological scales (Stevens, 1951, 1961) have been largely neglected by those gathering evidence concerning the psychological effects of various weapons. The available published data are almost entirely in the form of tables of percentages of individuals responding that they feared a certain weapon more or most

J. Dollard (1943) interviewed 330 wounded members of the Abraham Lincoln Brigade and presented two percentage lists which at first glance appear to be of some pertinence to the problem of developing an ordinal scale of psychological effects of weapons. In answer to the question, "Were there certain weapons or projectiles that you had special fear of

being wounded by?" the following data of Table 1 were obtained.

TABLE 1

Percentage of Men Indicating Fear of Each Weapon Class

Fear of being wounded by	Percentage of men answering
Bomb shrapnel	36%
Trench mortar	22%
Artillery shells	18%
Bayonet and knife	16%
Expanding bullets	16%
Grenades	6%
Others (Strafing, machine gun bullets, tanks, etc.)	13%

Based on Dollard (1943), p. 23.

It should be noted that 16% of the men did not fear one weapon more than another. Also, the total percentage is more than 100% since several men mentioned more than one weapon

The men were asked to rate their fear of different aspects of bombing, and these responses are recorded in Table 2. If in Tables 1 and 2 it is granted that the highest percentage has a rank of 1 and the lowest percentage a number corresponding to its place to the decreasing series of percentages, a rough approximation to an ordinal scale may be considered. There are, however, serious disadvantages in a scale of this type.

TABLE 2

Percentage of Men Indicating Fear of Different Aspects of Bombing

More frightened by	Percentage of men answering
Sound of bombs falling	38%
Sound and concussion of bombs exploding	33%
Sound of planes	11%
Sight of bombs falling	5%
Sight of bomb damage	3%
No difference	10%

Based on Dollard (1943), p. 25.

With respect to Table 1, the following observations appear reasonable:

1. Because several men mentioned more than one weapon (and the formulation of the question surely permits this), it is not apparent that the person drawing up the questionnaire on which the Table is based intended to construct an ordinal scale
2. Considering the form of the question, it does not necessarily follow that a weapon is most fearful because it is feared by the most people
3. There is no way of telling how much the experience factor influenced the responses tabulated in Table 1. It is possible

that a significant number of the men had no experience with expanding bullets, with bomb shrapnel, or with trench mortar. In other words, it is not specified that the experience backgrounds of the respondents are equal with respect to the various weapons mentioned in the Table.

4. It is improbable, therefore, that Table 1 has any value for the construction of an ordinal scale of psychological effectiveness of weapons.

While the task presented to the veterans who gave the responses in Table 2 appears to be a rating task, the tabular reports suggest that the men were asked to name the one aspect of bombing which terrified them more than any other aspect. Thus, 38% of the men were more frightened by the sound of bombs falling, while 33% were more frightened by the sound and concussion of bombs exploding. There is no apparent reason to assume that the responses of these men were normally distributed; therefore, from these data it is not possible to justify the construction of an interval scale. The validity of a simple ordinal scale based on these data is also questionable, because 10% of the men indicated equality in fearfulness of these weapons. Whether the veterans considered all weapons equally non-fearful, equally highly-fearful, or all of average fearfulness is left to the judgment of the reader.

S. A. Stouffer (1949) has presented data gathered from the volumes of the Research Branch, Information and Education Division, War Department, during World War II. Data presented in Tables 3 and 4 were gathered from the survey designated S-66 reported in July and August, 1943, which consisted of a study of a fear of enemy weapons as reported by combat returnees.

The exact number of cases on which each of the percentages in Tables 3 and 4 are based is not available since the punched cards and work sheets for this survey were not located. The total sample size of the survey lies between 700 and 800 men.

TABLE 3

Percentage of Men Exposed to Each Weapon Who Rated It Most Frightening

Based on responses to the question: "What enemy weapon used against you seemed most frightening to you?"

Weapon	Percent
88 mm. Gun	48%
Dive Bomber	20%
Mortar	13%
Horizontal Bomber	12%
Light Machine Gun	7%
Strafing	5%
Land Mines	2%
Rifle Fire	0%
Miscellaneous (Booby traps, tank attack, heavy machine gun, etc.)	4%

Based on Stouffer, et al. (1949), p. 232.

Stouffer points out that the men exposed to the 88 mm. gun were not, in all cases, the same as those men exposed to the dive bomber. He states further that since each percentage shown on the Table is calculated from a different base depending on the number of men exposed to the weapon,

these percentages do not total exactly 100%.

TABLE 4

Percentages of Men Exposed to Each Weapon Who Rated It Most Dangerous

Based on responses to the question: "Judging from what you yourself saw, what weapon used by the enemy caused the most casualties (killed and wounded) among our men?"

Weapon	Percent
88 mm. Gun	62%
Mortar	17%
Light Machine Gun	6%
Horizontal Bomber	5%
Dive Bomber	4%
Strafing	4%
Land Mines	2%
Rifle Fire	0%
Miscellaneous (Booby traps, tank attack, heavy machine guns, etc.)	2%

Based on Stouffer, et al. (1949), p. 233.

The remarks concerning the calculation of the percentages in Table 3 apply to Table 4 as well. It can be observed that, in general, the weapons considered most frightening are also rated the most dangerous. There is, however, one important rank order discrepancy showing the dive bomber to be considered the most frightening by 20% of the men while only 4% of the men considered it the most dangerous. Likewise, the horizontal

bomber is considered most frightening by 12%, but most dangerous by only 5% of the men. Stouffar points out that the apparently strong relationship between "dangerousness and frighteningness" is lessened by the fact that frequently the men who rated a particular weapon as most frightening were not the same as those who considered it most dangerous. In fact, only 38% of the men rated as most frightening the weapon which they considered most dangerous. The conclusion logically remains that the rating of the fearfulness of enemy weapons does not depend simply on the belief in the dangerousness of these weapons. The nature of other factors influencing the rating of fearfulness is suggested by the following quotations presented in Stouffer:

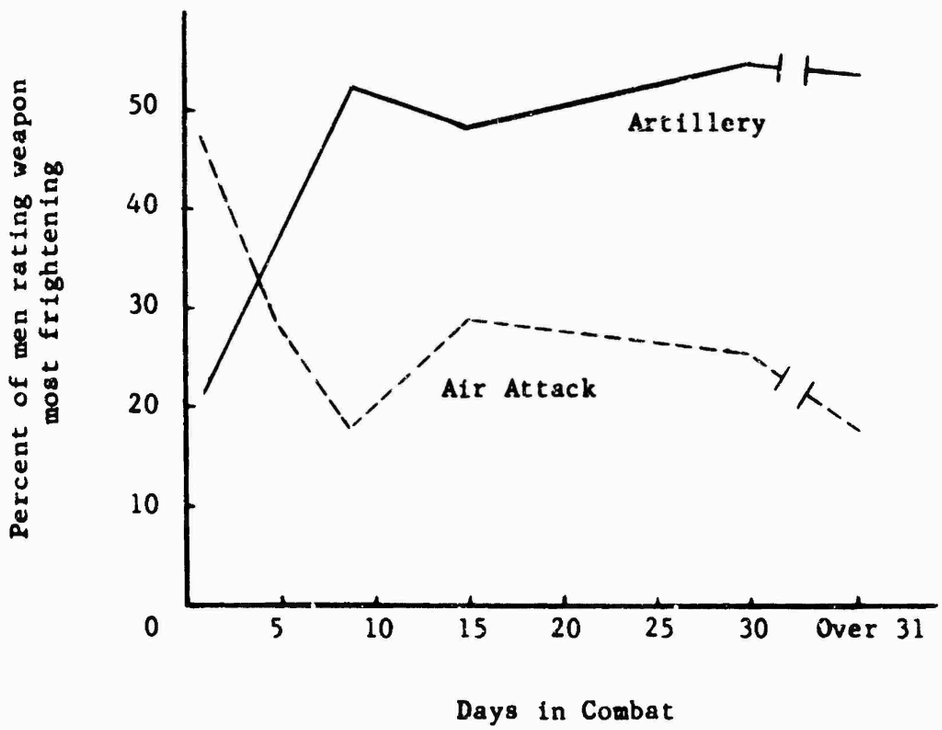
> Mortar: The mortar, the men say, is to be feared for its "deadly accuracy" (24%) and because "it is right on top of you before you know it's coming" (19%).
>
> 88 mm. Gun: The 88 is most frequently feared for its accuracy (21%). "They could hit a dime at a thousand yards with it."
>
> Light Machine Gun: "rate of fire" (42%). As one man said, "Our gun sounds like a slow motor boat, their's like a buzz saw."
>
> Dive Bomber: The dive bomber is feared because of its "siren" and its "terrible shrieking noise" (48%).
>
> Horizontal Bomber: The horizontal bomber is feared because of its noise (21%) and the fact that it leaves many men with the "feeling of helplessness." "You can't fight back at it " (14%)

It is interesting that the proportionality of the relationship between fearfulness and dangerousness of weapons increases with the amount of

experience that combat troops have with the weapon. With more experience, the soldiers' practicality of survival appears to adjust his fear to a maximum for weapons with real striking power and relatively less for objectively less effective weapons. This self-adaptive or learning characteristic of troops is very important in considering the validity of any ordinal scale of psychological effectiveness of weapons based on interview material. Chart I shows that experience may cause a complete reversal regarding the rating of "frighteningness."

CHART I

Ratings of the Fearfulness of Two Enemy Weapons in Relation to Length of Time in Combat



Based on Stouffer, et al. (1949), p. 236.

After analyzing the results of another survey (S-163) of 842 wounded combat veterans interviewed in four general hospitals in France and in a rehabilitation center in England, Stouffer (1949) found that the proportion of men who rated the 88 mm. gun as the most dangerous is smaller than the proportion who rated it the most fearful weapon, whereas the reverse relationship was true for the mortar. He interprets this finding as suggesting that "although the fear of the 88 mm. gun was grounded in its objective dangerousness, it evoked relatively greater fear response compared with its actual effectiveness than did the mortar." Table 5 is a comparison of reactions to two enemy weapons as rated by those who had been wounded by the weapon and those who had not been wounded by the weapon.

TABLE 5

Percentages Who	88 mm Gun	Mortar
Reported that they had been wounded by the weapon	25%	18%
Rated the weapon as the most dangerous one	43%	30%
Rated the enemy weapon as the one they feared most	52%	19%

Based on Stouffer, et al. (1949), p. 238.

Data obtained in this same survey (S-163) suggest that fear of the 88 mm. gun decreased under continued exposure to combat, while the mortar tended to be regarded as more dangerous and more fearful with increased time in combat. Tables 6 and 7 illustrate this change in rating of dangerousness

over time in combat.

TABLE 6

Changes in Reaction to the 88 mm. Gun with Increased Exposure to Combat

Days in Actual Combat	Percentage Who Say It Causes More Casualties Than Any Other Weapon	Percentage Who Say It Is the Enemy Weapon They Fear Most
0-29	50	59
30-59	39	53
60 & over	38	46

Based on Stouffer, et al (1949), p. 239.

TABLE 7

Changes in Reaction to the Mortar with Increased Exposure to Combat

Days in Actual Combat	Percentage Who Say It Causes More Casualties Than Any Other Weapon	Percentage Who Say It Is the Enemy Weapon They Fear Most
0-29	24	15
30-59	31	20
60 & over	40	23

Based on Stouffer, et al. (1949), p. 239.

Other data indicate that, with this sample of men, the 88 mm. gun caused a decreasing proportion of casualties with increased time in combat, whereas the mortar caused a somewhat increasing proportion with increased time in combat. These data are summarized in Table 8

TABLE 8

Percentage Wounded by Weapon According to Time in Combat

Time in Combat	Percentage Wounded by	
	88 mm.	Mortar
60 or over	19	16
30-59	22	21
under 30	35	12

Based on Stouffer, et al. (1949), p. 240.

H. Goldhamer, A. L. George and E. W. Schnitzer (1951) report two studies conducted among prisoners-of-war (POW's) taken in Korea. In Study No. I they examined POW opinions concerning the relative fear provoked and casualties inflicted by (a) three major weapon classes: air weapons, artillery, and infantry weapons; and (b) specific air weapons: napalm, strafing, rockets, bombs. Questionnaires were administered to 96 combat troop POW's (44 Chinese Communist and 52 North Korean) and to 47 medical POW's (11 Chinese Communist and 36 North Korean). The median length of front line combat service was 3 to 7 days for the 44 Chinese Communist POW combat troops and 1 to 2 months for the 52 North Korean POW's from combat troops. Both the combat and the medical POW's were asked to state which weapons the troops in their unit feared most. Thus, they were reporting, not their own personal reactions, but those of the unit to which they were attached. For the combat troops, the question was confined to fear in front line or combat areas, while the medical troops were permitted to respond concerning fear in any battle situation. Table 9

summarizes the data gathered on this question.

TABLE 9

Class of Weapons Most Feared by Combat and Medical POW's

Weapons	Percent Response Given	
	Combat POW's	Medical POW's
Air Weapons	42	52
Artillery	39	40
Infantry Weapons	19	8

Based on Goldhamer, et al. (1951), p. 9.

The POW's were asked also to give comments of their own troops regarding the characteristics of the weapons used against them. These comments revealed that certain weapons were more often the object of conversation than others. If it may be assumed that the most talked about weapon is also the most feared weapon, then Table 10 reinforces the data in Table 9.

TABLE 10

Weapons Most Talked About Among Combat POW's

Weapons	Percent Responses
Air Weapons	44
Artillery	40
Infantry Weapons	16

Based on Goldhamer, et al. (1951), p. 11.

In response to a further question: "Was any particular enemy weapon important in creating the desire to desert?" the data in Table 11 were obtained.

TABLE 11

Weapons Mentioned by Combat POW's As Important in Creating a Desire to Desert

Weapons	Percent Responses
Air Weapons	49
Artillery	45
Infantry	6

Based on Goldhamer, et al. (1951), p. 12.

Weapons may be feared because of audio-visual stimulus characteristics, by reason of reputation or accuracy, or by reason of actual effectiveness in inflicting casualties. In the absence of data obtained by field casualty counting procedures, the POW's were asked to judge which weapon or weapon class inflicted the greatest number of casualties while they were in front line positions. The medical personnel were requested to estimate which weapon caused the greatest number of casualties without respect to combat position On the basis of these estimates, Table 12 was constructed.

While it cannot be strongly argued that the POW estimates of casualty producing capabilities of weapons are to be taken at face value, nonetheless these estimates are of some interest in determining whether the POW's were more impressed by the fearfulness of a weapon class or by its casualty producing capability Goldhamer and his associates (1951) constructed the fear-casualty ratio (F-C ratio), which is simply the

proportion of judgments declaring a weapon as the most feared, divided by the proportion of judgments assigning it the highest casualty producing effectiveness. An F-C ratio greater than 1.00 signifies that the weapon received more votes as fearful than as casualty producing; an F-C ratio less than 1.00 signifies the reverse. The F-C ratios for the three major weapon classes under consideration are presented in Table 13.

TABLE 12

POW's Estimates of the Weapon That Inflicted the Greatest Number of Casualties

Weapons	Percent Responding	
	Combat POW's	Medical POW's
Air Weapons	38	33
Artillery	41	51
Infantry Weapons	20	16

Based on Goldhamer, et al. (1951), p. 16

TABLE 13

Fear-Casualty Ratios for Major Weapon Classes

Weapons	Combat POW's	Medical POW's	Weighted Average
Air Weapons	1.11	1.57	1.22
Artillery	.95	.78	.91
Infantry Weapons	.95	.50	.74

Based on Goldhamer, et al. (1951), p. 20.

It can be observed that the two sets of data agree in their assigning air weapons a ratio greater than 1.00, and in assigning artillery and infantry weapons ratios less than 1.00. Air weapons, then, display somewhat greater fear provoking characteristics than casualty inflicting power relative to the POW's. Artillery, on the other hand, is judged to be the most fearful weapon only slightly less often than it is judged physically most harmful. Finally, infantry weapons, while less fear producing, are regarded as a major casualty producing weapon class.

In the final portion of Study No. I, the combat POW's were asked to state which air weapons they feared most while they were in front line combat. The data obtained from this question are outlined in Table 14.

TABLE 14

Air Weapon Most Feared by Combat POW's

Weapon	Percent Responses
Napalm	60
Strafing	22
Rockets	11
Bombs	7

Based on Goldhamer, et al (1951), p. 22.

It should be observed that in all Tables (9 through 14), POW's were not limited to naming a single weapon as the most feared. The frequency of response to various weapons under the various categories, as reported in this paper, indicates that many individuals listed more than one weapon

in answer to the question presented them. For this reason, it is not possible to state that the various weapon lists can be readily converted to ordinal scales. This criticism, however, does not apply to Study No. II of the Rand Report, which will be described next.

In Study No. II of the Rand Report, Goldhamer, George, and Schnitzer (1951) present data based on the interrogations of 75 POW's who surrendered or were captured during the Spring of 1951, and of 72 POW's who surrendered or were captured during the late Summer of 1951. As in Study No. I, these data concern: (a) the amount of fear provoked by weapons and (b) the number of casualties produced by weapons The weapons which the POW's were asked to consider were: artillery, bombing napalm, rockets (air), and M/G strafing They were asked to examine the effectiveness of these weapons in one particular situation: when troops were dug in, in front line position. This study utilized the Method of Paired Comparison The POW's were asked in a questionnaire to compare each weapon with every other weapon individually, rather than simply to rank the five weapons in a single sequence of effectiveness. The questionnaire listed a set of ten choices, each choice requiring a comparison of fear producing capacity of two of the weapons; the same comparisons were made, also, with regard to casualty producing capacity Tables of data were constructed for both the Spring group of POW's and the late Summer group, each Table listing the proportion of times that each weapon was judged more fearful than each other weapon. These proportions are listed in the Rand Report, Tables 1, 2, and 3 on pages 32 and 33; and in Tables 5, 6, and 7, pages 36 to 38. The paired comparison data

were further reduced to five point scales representing the average relative effectiveness of the five weapons under each of the judgment conditions Goldhamer and associates (1951) made use of Thurstone's Law of Comparative Judgment. J. P. Guilford (1954) states this law as follows:

$$R_j - R_k = Z_{jk}\sqrt{\sigma^2_j + \sigma^2_k - 2r_{jk}\,\sigma_j\,\sigma_k}$$

where R_j and R_k = mean psychological values characteristically attached to stimuli S_j and S_k, respectively.

Z_{jk} = standard - measure distance or deviate from the mean of the unit normal distribution.

σ_j and σ_k = standard deviations of distribution of R_{hj} and R_{hk}, respectively.

r_{jk} = coefficient of correlation between R_{hj} and R_{hk}

The radical term in this equation is the standard deviation of the differences $R_{hj} - R_{hk}$ -- i.e. the unit of the scale on which each separation $R_j - R_k$ is expressed If certain assumptions are justified, this expression may be further simplified to read $R_j - R_k = Z_{jk}\sqrt{2}$. The assumptions on which this simplification is based are as follows: (a) there is no correlation between responses to any pair of stimuli; (b) the discriminal dispersions are all equal. The authors of the Rand Report point out that a test performed on the data (presumably the test of internal consistency, see Guilford (1954), p. 156) demonstrates clearly that the simplifying assumptions are not actually justified by the data.

Within the limitations of interpretation just established, it is nonetheless interesting to observe the scale values which these authors obtained for the paired comparison data on weapons. Table 15 presents

the scale values for weapon fearfulness, while Table 16 presents scale values for weapon physical effectiveness.

TABLE 15

Scale Values for Weapon Fearfulness Scales

Weapon	POW's Spring 1951	POW's Late Summer 1951
Artillery	1.16	2.20
Bombing	.48	1.39
Napalm	.88	1.09
Rockets	.29	.66
Strafing	.00	.00

Based on Goldhamer, et al (1951), p. 34.

It should be noted that these scales are to be read only within columns, not within rows, since each scale expresses only the position of any single weapon relative to other weapons within the same scale Between the two sets of scale values it may be observed that the range of fearfulness of weapons increased considerably between the Spring and late Summer of 1951. The difference in fearfulness between the most feared weapon and the least feared weapon was much greater in late Summer than in early Spring. Variations in the length of the scales and the resulting changes in the scale values support the statement that, on the average, artillery and bombing showed a large increase in estimated fearfulness, napalm and strafing showed a large decline, and rockets remained relatively stable.

TABLE 16

Scale Values for Weapon Physical Effectiveness Scales

Weapon	POW's Spring 1951	POW's Late Summer 1951
Artillery	1.12	2 51
Bombing	.29	1.24
Napalm	.43	1.06
Rockets	.06	.71
Strafing	.00	.00

Based on Goldhamer, et al. (1951), p. 38.

As in the interpretation of Table 15, statistical comparisons are to be made within columns, not within rows Again it will be noticed that the scale is considerably lengthened in the late Summer as compared to Spring and that the difference between the physically least effective weapon and physically most effective weapon increased considerably in the opinion of the POW's It is of interest further to observe that during the Spring of 1951, napalm was judged to have inflicted more casualties than bombing, while in the late Summer it was judged to have inflicted fewer casualties than bomb'ng. This may be accounted for by the fact that during the Spring there was very little MPQ2 fragmentation bombing, which was largely employed during the middle and late Summer periods. A generalization based on this scale permits one to say, that on the whole, artillery and bombing gained in POW estimation of physical effectiveness, strafing declined, while napalm and rockets remained relatively unchanged in their opinion.

It is of further interest to compare the scales of fear and of physical effectiveness, and to observe that in general the POW evaluations of relative fearfulness are very similar to their evaluations of relative physical effectiveness, with certain minor differences. These differences are that, while artillery leads both scales, it ranks relatively higher on the physical effectiveness scale than it does on the fearfulness scale. Napalm, on the other hand, ranks higher in fearfulness than in physical effectiveness relative to other weapons.

From the point of view of present work, it is unfortunate that the foregoing questionnaire material and scales were based on separate groups of POW's rather than upon observation of friendly troops, who might be expected to show some type of adaptation between the Spring combat and Summer combat Since the early Spring and the late Summer POW's are definitely different groups, it is also possible that they have quite different approaches to the paired comparison tasks. The resulting scales might differ not only because of change of attack mode between the Spring and the late Summer, but also by reason of individual differences within these groups. Present work would be further benefited if it were possible to obtain objective enumerations of casualties inflicted by each of the weapons evaluated in the study.

Stanford Research Institute (1953), making use primarily of the documents and reports gathered in the United States Strategic Bombing Survey (USSBS), has made a summary of the available data concerning the psychological effectiveness of World War II weapons. Unfortunately, little of this material was gathered in a form useful in constructing a psychological scale of weapons effectiveness. Furthermore, the

It is of further interest to compare the scales of fear and of physical effectiveness, and to observe that in general the POW evaluations of relative fearfulness are very similar to their evaluations of relative physical effectiveness, with certain minor differences. These differences are that, while artillery leads both scales, it ranks relatively higher on the physical effectiveness scale than it does on the fearfulness scale. Napalm, on the other hand, ranks higher in fearfulness than in physical effectiveness relative to other weapons.

From the point of view of present work, it is unfortunate that the foregoing questionnaire material and scales were based on separate groups of POW's rather than upon observation of friendly troops, who might be expected to show some type of adaptation between the Spring combat and Summer combat Since the early Spring and the late Summer POW's are definitely different groups, it is also possible that they have quite different approaches to the paired comparison tasks. The resulting scales might differ not only because of change of attack mode between the Spring and the late Summer, but also by reason of individual differences within these groups. Present work would be further benefited if it were possible to obtain objective enumerations of casualties inflicted by each of the weapons evaluated in the study.

Stanford Research Institute (1953), making use primarily of the documents and reports gathered in the United States Strategic Bombing Survey (USSBS), has made a summary of the available data concerning the psychological effectiveness of World War II weapons. Unfortunately, little of this material was gathered in a form useful in constructing a psychological scale of weapons effectiveness. Furthermore, the

TABLE 16

Scale Values for Weapon Physical Effectiveness Scales

Weapon	POW's Spring 1951	POW's Late Summer 1951
Artillery	1.12	2 51
Bombing	.29	1.24
Napalm	.43	1.06
Rockets	.06	.71
Strafing	.00	.00

Based on Goldhamer, et al. (1951), p. 38.

As in the interpretation of Table 15, statistical comparisons are to be made within columns, not within rows Again it will be noticed that the scale is considerably lengthened in the late Summer as compared to Spring and that the difference between the physically least effective weapon and physically most effective weapon increased considerably in the opinion of the POW's It is of interest further to observe that during the Spring of 1951, napalm was judged to have inflicted more casualties than bombing, while in the late Summer it was judged to have inflicted fewer casualties than bombing. This may be accounted for by the fact that during the Spring there was very little MPQ2 fragmentation bombing, which was largely employed during the middle and late Summer periods. A generalization based on this scale permits one to say, that on the whole, artillery and bombing gained in POW estimation of physical effectiveness, strafing declined, while napalm and rockets remained relatively unchanged in their opinion.

report was limited mainly to the effects of various types of bombs. The USSBS contains surprisingly little information that would be of value in determining the effects of different types of bombs on German morale and attitudes toward work and war While there is some indication that high explosive bombs ("blockbusters") were more feared than incendiary bombs, there were also indications that incendiary bombs caused considerable disorganization when attacks were made at night. There is further indication that the use of phosphorous in British 30-pound oil bombs was very effective, but it is not clear whether this effectiveness lay in the physical damage produced by these bombs or in the fear and confusion produced by the phosphorous smoke. Only one attempt was made at scaling the effects of various types of bombs, this being among foreign workers who had been gathered to man German factories Considering that the meaning of bombing attacks was probably very different for foreign workers than it was to German citizens, in that foreign workers might see attacks as enhancing the possibility of their own liberation, the following tabular data (shown in rank order, but without supporting data such as numbers and percentages) are of interest

The ordinal scale of Table 17 varies from most dreaded (1) to least dreaded (5) type of bomb. It will be observed that the foreign workers were in unanimous agreement concerning incendiary bombs, in that they assigned this class of bombs to the least dreaded category, while they agree also in assigning delayed action bombs to the next least dreaded category. The French and Italian workers considered air mines to be the most dreaded. The Russians, on the other hand, considered large bombs to be most dreaded, while they assigned air mines to be next

most dreaded rank order.

TABLE 17

Types of Bombs Reported as Most Dreaded

	Nationality of Workers		
	French	Italian	Russian
Air Mines	1	1	2
Large Bombs	3	2	1
Phosphorous	2	3	3
Delayed Action	4	4	4
Incendiary	5	5	5

Based on Stanford Research (1953), p. 82.

In the part of the USSBS report (1947) concerned with the effects of bombing on the Japanese, the following data were reported in response to the question "What kind of bomb do you think is worse--incendiary or explosive?"

TABLE 18

High Explosive vs. Incendiary Bombs

	Percent
High explosive worse	63
One as bad as the other	17
Incendiary worse	15
No answer	5

Based on USSBS (1947), p. 38.

The most commonly assigned reason for fear of high explosive bombing was that it was more difficult to escape death or injury from that class of bomb. In addition to this, the noise and concussion was considered to add to the fearfulness of high explosives. It will be observed that Table 18 is of little value in constructing a scale of weapons effectiveness, but that it is indicative of the relative value of incendiary vs. high explosives on the Japanese population The Japanese portion of the USSBS is of more interest concerning the behavioral effects of attack rather than the specific effectiveness of any particular weapon In Table 19 are summarized data concerning the emotional reactions of the Japanese to bombing of all types

TABLE 19

Most Common Emotional Reaction to Bombing Experiences

Emotional Response	Percent
Fright and terror	39
Fear that respondent and family would be killed	18
Other responses indicating fear	8
Confusion, paralyzed action, and thinking	10
Excitement at time of raid	9
No fright at time of raid	4
Belief that he and/or family not injured	3
Other responses indicating composure	2
No answer: no emotional reactions indicated	23

Based on USSBS (1947), p. 35.

The outward behavior of the Japanese under bombing attack took several forms. Most of the adults, it is reported, ran to the shelters when the raids began, remaining there instead of making any effort to fight the destructive fires or to participate in rescue operations Table 20 indicates the general behavior patterns of the Japanese people during air raids

TABLE 20

Behavior Patterns of Japanese During Air Raids

Reaction	Percent
Respondent ran to shelter or took family to shelter; made no comment about fighting fires, etc.	45
Fought fires	18
Remained outside of shelter; no indication of fighting fires	12
Left town immediately after raid	5
Miscellaneous behavior	7
No answer	15

Based on USSBS (1947), p. 36.

There is some indication that the urban population of Japan became more adapted as their bombing experience increased, while the rural people, who had less direct experience, became less adapted. Table 21 suggests that in the population at large approximately 40% showed increased adaptation

TABLE 21

Adaptation to Continued Raids

Adaptation	Percent
Became better adapted--as raids continued, fears decreased; became used to it	41
Did not fear raids either at beginning or at end	1
Feared raids at beginning and feared them just as much as raids went on	4
Adaptation variable--fearing decreased or increased according to circumstances	5
Became less adapted--fears increased as raids continued	41
No answer--don't know	8

Based on USSBS (1947), p 37.

Interview material further suggests that among the urban group the most common reason for increased fear, in those instances where there was no adaptation, was that the raids increased significantly in frequency, size, and proximity.

The Operations Research Office (ORO) of the Johns Hopkins University explored various methods for measuring the psychological effects of weapons whose primary purpose is to inflict enemy casualties. In this study, they interrogated both Chinese Communist and North Korean prisoners-of-war to measure their reaction to UN weapons, and to discern the reasons for their reactions Table 22 summarizes the data concerning the weapon classes most feared by the respondents.

TABLE 22

Weapon Classes Most Feared

Weapon Class	Chinese Forces (N = 288)	North Koreans (N = 69)
Air	48.0%	67 0%
Artillery	39.0	22.0
Mortar	0.5	-
Tank	9.0	2.5
Infantry	1.0	8.5
Naval Bombardment	-	-
Bazooka	2.5	-

Based on Kahn (1952), p. 15.

Weapon classes were further broken down into air weapons and ground weapons, and data analyzed and tabulated regarding fearfulness of each of these classes. In Table 23 are listed the percentages of individuals indicating that they feared each of the air weapons.

TABLE 23

Kinds of Air Weapons Feared

Air Weapons	Chinese Forces (N = 297)	North Koreans (N = 62)
Machine Gun	18.0%	43.5%
High Explosive	17.5	9.5
White Phosphorous	19.5	0.5
Napalm	36.0	37.0
Rockets	9 0	9.5

Based on Kahn (1952), p. 26.

In Table 24 are presented the percentages of individuals indicating their fear of ground weapons.

TABLE 24

Kinds of Ground Weapons Feared

Ground Weapons	Chinese Forces (N = 283)	North Koreans (N = 45)
Machine Gun	29.0%	11.0%
Rifle	1.5	7.0
High Explosives	45.0	82.0
White Phosphorous	16.0	-
Grenades	2.5	-
Flame Thrower	6.0	-

Based on Kahn (1952), p. 34.

Neither Table 23 nor 24 is of extensive value in scale construction. In Table 23 the number of responses given by the Chinese Communists exceeds the total number of respondents, while the number of responses given by the North Koreans is less than the number of respondents (in the latter instance because of "no answers"). The number of responses in Table 24 given both by the Chinese Communists and the North Koreans is less than the total number of respondents (because of "no answers"). A variety of reasons were assigned by the respondents for fearing the various weapon classes. Among these reasons are casualties, noise, efficiency of action, burning, restriction of activities, invulnerability, miscellaneous effects (property damage, breakdown of morale, etc.). In

Table 25 are offered data concerning the frequency of respondents who offered each reason for fearing the weapon classes.

TABLE 25

Reasons for Fearing Weapon Classes

Reason	Chinese Forces (N = 350)	North Koreans (N = 69)
Casualties	166	66
Noise	10	2
Efficiency of Action	79	0
Burning	0	0
Restriction of Activities	34	0
Invulnerability	8	0
Miscellaneous Effects	53	1

Based on Kahn (1952), p. 21.

It will be observed that casualties is the most frequently cited reason for fear both by the Chinese Communists and North Koreans. For the North Koreans, this may be considered the only reason. It is interesting to observe further that, for the Chinese group, efficiency of action of our weapon classes stands out as an important reason for fear, second only to the casualty inflicting characteristic Table 25 also suggests that the weapons which produce the most casualties, are rated most efficient in action,and are most restrictive of the activities of the forces against whom they are directed.will be most psychologicaly effective (most productive of fear).

In another study reported by the Operations Research Office of the Johns Hopkins University, the UN weapons were examined from the point of view of their capability of affecting morale and military efficiency of Chinese Communist forces and North Korean Army troops. Specifically, this study sought to examine in enemy POW's the relationship between exposure to the effects of specific types of weapons and the performance of soldiers engaged in military action in Korea during the period from February through August, 1951. The focus of the study, therefore, is the psychological effects of physical exposure to fire from different types of weapons. It was assumed that this exposure could so upset an individual that his subsequent behavior or performance would be affected. A major weakness of this study consists of the fact that objective information was not available on whether exposure to a particular type of weapon fire took place before or after any incident of ineffective performance. It was further impossible to ascertain weapon fire exposure immediately prior to the start of the week in which ineffective performance may or may not have occurred. A total of 860 POW's were interviewed, of whom 4 were eliminated by reason of having been prisoners-of-war longer than one week Of these 856, 593 were able to cite examples of their own ineffective performance (which may have an association with some type of UN fire). In Table 26 are recorded the types of incidents of ineffective behavior cited by the POW's and the percentage of POW's indicating each type of ineffective behavior.

A variety of UN weapons were cited as having been experienced prior to the reported incidences of ineffective behavior. These weapons are listed in Table 27.

TABLE 26

Percentages of Incidents of POW's Own Ineffective Performance by Type of Behavior

Behavior	Own Ineffective Performance (1056 cases)
Ineffective in routine assignment	61.7
Ineffective under UN fire	13.3
Deserted	8.2
Claimed illness or injured self to avoid assignment	8 7
Temporarily left post	3.8
Circumstances prevented good performance	4.3

Based on Kahn (1954), p. 21

TABLE 27

Percentages of Responses Indicating a Particular Weapon Having Been Experienced Immediately Prior to the Incidents of Ineffective Performance

Weapon Type	Percentage
Artillery	68.9
Air Strafing	67.4
Rifle	64.5
Machine Gun	61 7
Air Bomb	58.6
Mortar	53 2
Air Napalm	44.8
Air Rocket	41.1
Tank	29.8
Grenade	19 7
Mine	9 2

Based on Kahn (1954), p. 22.

Note that it is not certain that exposure to specific weapons occurred prior to ineffective performance.

It is of further interest to consider the possible relationship between exposure to UN fire and subsequent capture or surrender. In Table 28 are listed the percentage of responses made by POW's concerning exposure to UN weapon fire.

TABLE 28

Percentage of Responses Indicating Exposure to UN Weapons Fire, Cited by 420 Captured and 332 Surrendered POW's

Weapon Type	Captured POW's	Surrendered POW's
Rifle	79.2	47.5
Air Strafing	75.9	56.0
Artillery	75.0	59.9
Machine Gun	74.5	46.6
Mortar	62.8	44.5
Air Bomb	60.2	54.2
Air Napalm	49.2	36.0
Tank	46 2	19.2
Air Rocket	44.1	34.9
Grenade	26.1	11.7
Mine	11.4	7.2

Based on Kahn (1954), p. 18.

It is not possible to establish either for Table 27 or for Table 28 a cause-effect relationship between exposure to UN fire and subsequent action, whether this be capture, surrender or "ineffective behavior." Chi-square Contingency Tests, reported in Table 2 on page 19 of Kahn (1954), reveal that for certain weapons the association found between exposure

to them and capture is statistically significant. Significant relations were found for both the Chinese Communist forces and the North Korean Army POW's with respect to the rifle, machine gun, mortar, tank, napalm, and air strafing. For the Chinese Communist forces, there were additional significant relationships between prior exposure to fire from artillery and air rockets and subsequent surrender. These were not significantly related to capture among the North Korean Army POW's. Additional Chi-square Contingency Tests were performed on the data regarding occurrence of ineffective performance among the CCF and NKA soldiers and their exposure to land weapons fire. For both the CCF and NKA soldiers who later became prisoners, statistically significant associations were found between ineffective performance and exposure to bombing and strafing. Both air napalm and artillery fire were found to be significant for the NKA, but insignificant for the CCF.

Finally, the same report lists data concerning the weapon types involved in effective enemy fire against US units, as cited by 257 US soldiers. The total number of citations, whether made as one specific weapon or as a selected combination, are listed in Table 29.

TABLE 29

Weapon Types Involved in Effective Enemy Fire Against US Units Cited by 257 US Soldiers

Weapon	Frequency of Citation
Mortar	147
Automatic Infantry Weapon	145
Machine Gun	142
Grenade	81
Small Arm	48
Artillery	47
Mine	2
Tank	0

Based on Kahn (1954), p. 32.

Since it is quite possible that the frequency of citation in Table 29 is directly proportional to the frequency with which these weapons either were used by the enemy or were experienced by US troops, it is uncertain whether this list contributes information of value for scaling the psychological effectiveness of weapons.

Implications for the Psychological Index

Among the various reported studies of psychological effects of weapons, only Study No. II of Goldhamer and associates (1951) meets the basic requirements for developing a psychological scale. However, the findings of all of the studies taken together point toward certain common elements which should be considered in developing a psychological scale of weapons effectiveness. It is recommended, therefore, that the Psychological Index include measures of:

1. Psychophysical effects, consisting of reactions to light and sound characteristics of a weapon. Stouffer's (1949) data (p. 7, this report), Dollard's (1943) report (Table 2, this report) and Kahn's (1952) findings (Table 25, this report) suggest among other factors the importance of sensory characteristics of weapons in producing fear.

2. Psychological effects, consisting of beliefs regarding a weapon's accuracy and lethality, as well as the modifications of these beliefs by reason of personal experience (adaptation). Stouffer's (1949) suggestion of a change in the rating of fearfulness with time in combat (Tables 6 and 7, this report) and Goldhamer's (1951) findings of a difference in scale values of weapon fearfulness between experienced and inexperienced troops (Table 15, this report) support this recommendation.

3. Psychosocial effects, consisting of such variables as morale level, leadership characteristics, and cultural determinants. The

importance of the latter is suggested in the study by the Stanford Research Institute (1953), which shows French, Italian, and Russian POW's differing in their rankings of fearfulness of bombs (Table 17, this report). Further support is given by Kahn's (1952) data showing differences between Chinese and North Korean POW's ranking of feared weapons (Tables 22, 23, and 24), as well as differences in the reasons they offered for their fear (Table 25). A further study suggests a relationship between certain weapon classes and troop morale (Tables 26 and 27, this report), particularly as measured by effectiveness of performance.

The general form of the Psychological Index would include, then, measures of psychophysical, psychological, and psychosocial effects of weapons. The mathematical expression of the relationship between these three effects will be developed in Part II of this report, along with a methodology for determining the Psychological Index value for specific weapons.

REFERENCES

Dollard, J., (1943) "Fear in Battle" The Institute of Human Relations, New Haven: Yale University.

Goldhamer, H., George, A L , and Schnitzer, E. W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)," (U). RM-733, Santa Monica, California: The Rand Corporation.

Guilford, J. P., (1954) "Psychometric Methods." New York City, New York: McGraw-Hill Book Company, pp. 154-168.

Kahn, L. A., (1952) "A Preliminary Investigation of Chinese and North Korean Soldier Reactions to UN Weapons in the Korean War," ORO, Johns Hopkins University, ORO-T-14(FEC).

Kahn, L A., (1954) "A Study of Ineffective Soldier Performance Under Fire in Korea," ORO, The Johns Hopkins University, ORO-T-62 (AFFE)

Stanford Research Institute, (June 1953) "Impact of Air Attack in World War II: Selected Data for Civil Defense Planning, Div. 3: Social Organization Behavior and Morale Under Stress of Bombing, Vol. I: Public Attitudes and Behavior," prepared for Federal Civil Defense Administration, Washington, D. C.

Stevens, S. S., (1951) "Mathematics, Measurements, and Psychophysics." In Stevens, S. S. (Editor), Handbook of Experimental Psychology. New York: Wiley and Sons, Chapter 1, pp. 1-49.

Stevens, S. S , (1961) "The Psychophysics of Sensory Function." In Rosenblith, W A (Editor), Sensory Communication, Cambridge, Mass : The M I.T Press, Chapter 1, pp. 1-33.

Stouffer, S. A., et al., (1949) "The American Soldier: Combat and Its Aftermath," Vol. II. Princeton, New Jersey: Princeton University Press.

U S. Strategic Bombing Survey, Morale Division, (1947) "The Effects of Strategic Bombing on Japanese Morale," Washington, D. C : U S. Government Printing Office

TABLES

1 Dollard, J , (1943) "Fear in Battle." The Institute of Human Relations, New Haven: Yale University, p. 23.

2. Dollard, J., (1943) "Fear in Battle." The Institute of Human Relations, New Haven: Yale University, p. 25.

3. Stouffer, S. A., et al., (1949) "The American Soldier: Combat and Its Aftermath," Vol. II Princeton, New Jersey: Princeton University Press, S-66 survey, p. 232.

4 Stouffer, S. A , et al., (1949) "The American Soldier: Combat and Its Aftermath," Vol. II. Princeton, New Jersey: Princeton University Press, S-66 survey, p. 233

5. Stouffer, S. A., et al., (1949) "The American Soldier: Combat and Its Aftermath," Vol. II. Princeton, New Jersey: Princeton University Press, adapted from Chart 9, p. 238.

6. Stouffer, S A., et al., (1949) "The American Soldier: Combat and Its Aftermath," Vol. II Princeton, New Jersey: Princeton University Press, survey S-163, p. 239.

7 Stouffer, S. A , et al , (1949) "The American Soldier: Combat and Its Aftermath," Vol II Princeton, New Jersey: Princeton University Press, survey S-163, p. 239.

8 Stouffer, S. A , et al., (1949) "The American Soldier: Combat and Its Aftermath," Vol. II Princeton, New Jersey: Princeton University Press, p. 240

9 Goldhamer, H., George, A L., and Schnitzer, E. W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, p. 9.

10. Goldhamer, H., George, A L., and Schnitzer, E. W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, p. 11.

11. Goldhamer, H., George, A L., and Schnitzer, E. W , (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, p. 12.

TABLES

12. Goldhamer, H., George, A. L., and Schnitzer, E W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, p. 16.

13. Goldhamer, H., George, A. L., and Schnitzer, E. W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif , The Rand Corporation, p 20.

14. Goldhamer, H., George, A L., and Schnitzer, E. W , (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, p. 22.

15. Goldhamer, H., George, A. L., and Schnitzer, E W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, Table 4, p. 34.

16. Goldhamer, H., George, A. L., and Schnitzer, E. W., (Dec. 1951) "Studies of Prisoner-of-War Opinions on Weapons Effectiveness (Korea)" (U), RM-733, Santa Monica, Calif., The Rand Corporation, Table 8, p. 38.

17. Stanford Research Institute, (1953) "Impact of Air Attack in World War II: Selected Data for Civil Defense Planning, Div 3: Social Organization Behavior and Morale Under Stress of Bombing, Vol. I: Public Attitudes and Behavior, prepared for Federal Civil Defense Administration, Washington, D C , p. 82.

18. U. S. Strategic Bombing Survey, Morale Division, (1947) "The Effects of Strategic Bombing on Japanese Morale," Washington, D C.: U. S. Government Printing Office, p. 38.

19. U. S. Strategic Bombing Survey, Morale Division, (1947) "The Effects of Strategic Bombing on Japanese Morale," Washington, D C.: U. S. Government Printing Office, p. 35.

20. U. S. Strategic Bombing Survey, Morale Division, (1947) "The Effects of Strategic Bombing on Japanese Morale," Washington, D C.: U. S Government Printing Office, p. 36.

21. U S. Strategic Bombing Survey, Morale Division, (1947) "The Effects of Strategic Bombing on Japanese Morale," Washington, D. C.: U. S. Government Printing Office, p 37.

TABLES

22. Kahn, L. A., (1952) "A Preliminary Investigation of Chinese and North Korean Soldier Reactions to UN Weapons in the Korean War," ORO, Johns Hopkins University, ORO-T-14(FEC), p. 15.

23. Kahn, L. A., (1952) "A Preliminary Investigation of Chinese and North Korean Soldier Reactions to UN Weapons in the Korean War," ORO, Johns Hopkins University, ORO-T-14(FEC), p. 26.

24. Kahn, L. A., (1952) "A Preliminary Investigation of Chinese and North Korean Soldier Reactions to UN Weapons in the Korean War," ORO, Johns Hopkins University, ORO-T-14(FEC), p. 34.

25. Kahn, L. A., (1952) "A Preliminary Investigation of Chinese and North Korean Soldier Reactions to UN Weapons in the Korean War," ORO, Johns Hopkins University, ORO-T-14(FEC), p. 21.

26. Kahn, L. A., (1954) "A Study of Ineffective Soldier Performance Under Fire in Korea," ORO, The Johns Hopkins University, ORO-T-62 (AFFE)., Table 3, p. 21.

27. Kahn, L. A., (1954) "A Study of Ineffective Soldier Performance Under Fire in Korea," ORO, The Johns Hopkins University, ORO-T-62 (AFFE)., Figure 4, p 22.

28. Kahn, L. A., (1954) "A Study of Ineffective Soldier Performance Under Fire in Korea," ORO, The Johns Hopkins University, ORO-T-62 (AFFE)., Figure 2, p. 18.

29. Kahn, L. A., (1954) "A Study of Ineffective Soldier Performance Under Fire in Korea," ORO, The Johns Hopkins University, ORO-T-62 (AFFE)., p. 32.